air may be at atmospheric pressure or it may be compressed. In a presently preferred best-mode embodiment, the process employs catalytic amounts of palladium-containing materials on a support with low resistance to gas flow.

[0052] The fuel/air mixture supplied to the catalyst should be premixed well and the gas inlet temperature may be varied depending on the fuel used. This temperature may be achieved by preheating the gas through heat exchange, or adiabatic compression.

[0053] Both the bulk outlet temperature of the partially combusted gas leaving the zone containing the catalyst and the temperature of the wall which contains the catalyst will be at temperatures significantly lower than the adiabatic combustion temperature of the gas. Generally, neither the bulk outlet gas temperature nor the wall temperature will be more than about 800°C, and preferably below 750°C. In addition, the catalyst temperature should not exceed 1000°C and preferably not exceed 950 °C. These temperatures will depend on a variety of factors including the pressure of the system, the partial pressure of oxygen, the caloric content of the fuel, and the like. Nevertheless, the catalyst will combust the fuel, but it will limit the ultimate temperature to a value lower than the adiabatic combustion temperature because a large fraction of the heat released by the combustion reaction will be absorbed by the (endothermic) steam reforming reaction on the other side of the separator plate. The ability to limit combustion temperatures by transferring the heat of combustion from the combustion catalyst to the reforming catalyst through a solid phase (metal) allows the design of smaller reactors operating at lower temperatures than those proposed in the prior art.

I. The Reforming Zone

[0054] The reforming fuel is mixed with steam to produce a mixture having an $H_2O:C$ ratio ≥ 1, preferably in the range of from about 1 to about 5, and most

preferably about 3 ± 0.5. The mixture may be at atmospheric pressure or it may be compressed. In a presently preferred best-mode embodiment, the process employs catalytic amounts of palladium-containing and rhodium-containing materials on a support having low resistance to gas flow.

[0055] The steam/fuel mixture supplied to the catalyst should be premixed well and the inlet temperature may be varied depending on the fuel used. This temperature may be achieved by preheating the mixture through heat exchange. Reforming catalyst temperatures will be essentially the same as the combustion catalyst temperature, because heat transfer resistances in the thin foil or platelet-type separator plate are typically negligible.

J. The Separator

[0056] The preferred materials for the separator plate foils or platelets include: aluminum-containing or aluminum-treated steels; stainless steels suitable for thermal reaction environments; and any high-temperature metal alloy, including nickel, cobalt or nickel alloys where a catalyst layer can be deposited on the metal surface.

[0057] The preferred materials for the foils and platelets are aluminum-containing steels, such as those found in U.S. Patents 4,414,023 to Aggen et al., 4,331,631 to Chapman et al., and 3,969,082 to Cairns, et al., the disclosures of which are hereby incorporated by reference to the extent needed for full description of the composition and properties of such steels. These steels, as well as others available from Kawasaki Steel Corporation (River Lite 20-5 SR), Vereinigte Deutchse Metallwerke AG (Alumchrom I RE), and Allegheny Ludlum Steel (Alia-IV), contain sufficient dissolved aluminum so that, when oxidized, the aluminum forms alumina whiskers or crystals on the sheet surface in order to provide a rough and chemically reactive surface for better adherence of the catalytic coating. Alternatively, the separator plates may be made of high strength nickel chromium alloys such as Haynes 230 or

Haynes 214 made by the Haynes Company, Inconel, Hastalloy X or a variety of other high strength alloys. Preferred alloys contain aluminum or additionally can be coated with aluminum by electroplating, cladding, vapor deposition, chemical vapor deposition or other processes that would apply a layer of aluminum to the metal sheet. One preferred material for the separator is an iron chromium aluminum alloy, which may also contain small amounts of other additives. Another preferred material is a nickel chromium aluminum alloy, which may also contain small amounts of other additives.

[0058]   The separator plates are generally thin compared to the transverse-flow plate. The typical thickness of a separator plate is from between about 0.001 and 0.1 inch thick, preferably between about 0.002 and 0.040 inch thick and most preferably between about 0.002 and 0.02 inch thick. The thickness represents a balance between manufacturability, ease of forming the structure of the separator plate, good heat transfer between the exothermic catalyst and the endothermic catalyst, and the final weight of the plate reactor.

[0059]   Prior to coating with the catalyst, the separator sheet should be heat treated to form a surface layer conducive to adhesion of the catalyst layer. This is typically done by heating in air at temperatures in the range of 900 to 1100°C to form an aluminum oxide layer at the surface of the metal sheet. For some alloys, the preferred process involves heating in a hydrogen and steam containing atmosphere to preferentially form aluminum oxide at the surface. The catalytic coating may be applied in the same fashion one would apply paint to a surface, e.g., by spraying, direct application, dipping the support into the catalytic material, and the like procedures. Catalytic materials suitable for combustion of fuels, and methods for depositing those materials on the combustion side of the separator plates, are described in U.S. Patent 5,259,574 of Dalla Betta et al., the disclosure of which is hereby incorporated by reference. Those catalytic coating compositions are typically mixed oxides such as alumina, silica alumina, silica/gamma alumina, zirconia or